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Early learning in autism as an atypical balance between assimilation and accommodation
processes

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Abstract

Many children on the autism spectrum are capable of learning large amounts of material in specific areas - yet, they often show learning delays across multiple domains. Additionally, they typically show the ability and motivation to learn from practice and from the outcomes of their own actions while having difficulties learning from novel situations and from others' actions and communications. We propose that these and other phenomena reflect, in part, an atypical balance between cognitive assimilation and accommodation processes during early childhood. Adopting a constructivist perspective that connects Piaget's heuristics with experimental and clinical research in autism, we examine empirical supports as well as implications of this notion for autism research, advocacy, and intervention.

KEYWORDS: Autism, Constructivism, Early Learning, Early Intervention, Neurodiversity, Advocacy

Early Learning in autism as an atypical balance between assimilation and accommodation
processes

For most young autistic children¹, early learning does not proceed in typical fashion. Many children diagnosed with autism show delays in learning in the second and third years of life in most developmental domains measured by standardized assessments, which often grow larger over time (Thurm et al., 2019). Yet children and adults on the autism spectrum, both those with cognitive delays and those without, often demonstrate mastery of information about subjects that interest them at more sophisticated levels than would be predicted by their cognitive test data. This is seen in young children's early recognition of letters, shapes, words, names of vehicles, memorized signs, books (Harrop et al., 2019; Wang et al., 2020), and in older children's and adults' unusually detailed knowledge of areas of interest (Turner-Brown & Frisch, 2020; Zhao et al., 2019). In contrast, most autistic children show a more limited engagement in object exploration, especially of novel objects (Fanning et al., 2021), more repetition in their play, and less use of novel word combinations and play combinations than do their developmentally matched peers (Carmo et al., 2013; Kasari & Chang, 2014; Kim et al., 2014). Additionally, autistic children appear to learn from the outcomes of their own goal-directed actions in ways similar to their peers while experiencing difficulties in learning from observation and imitation of others' actions (Foti et al., 2019; Vivanti et al., 2014, 2016a).

¹ Community opinions regarding language use are mixed (Bury et al., 2020; Vivanti, 2020), but many find the expression "with autism" to be potentially stigmatizing (Botha et al., 2021; Gernsbacher, 2017; Kenny et al., 2016). Therefore, in alliance with preferences of many autistic people, we have chosen to use the expressions "autistic" or "on the autism spectrum". Furthermore, due to autistic community non-endorsement of terms like "disorder" and "condition" (Kenny et al., 2016), we have chosen to use more descriptive terms, like "autism spectrum development".

The processes underlying these puzzling phenomena remain unclear, and understanding them has the potential to deepen our knowledge about the nature of autism and inform intervention targets and procedures. In the following, we adopt a constructivist perspective to examine the early learning differences observed in young children on the autism spectrum and we outline a novel explanatory framework. In the first section of the paper, we will develop the hypothesis that early learning differences in autism can be conceptualized as an atypical balance between assimilation and accommodation processes. The next section of the paper will examine the empirical support for this notion across clinical, experimental and neuroscientific research. The third section of the paper will address the relevance of the proposed constructivist framework for autistic advocacy. The final section of the paper will take an intervention science perspective to suggest how early intervention and early education might scaffold young autistic children's use of both assimilation and accommodation to support the construction of adaptive social learning.

Impact of Early Emerging Symptoms of Autism on Accommodation and Assimilation Normative and Non-Normative Constructions of Knowledge Through a Developmental Lens

Our understanding of early development and learning in autism has been critically influenced by the adoption of developmental psychopathology approaches that compare and contrast normative and non-normative developmental processes in order to deepen our understanding of both (Cicchetti & Cohen, 1995). In the autism field, knowledge gained from studies of normative development has served as a foundation to ask questions and test hypotheses about autistic development, and vice versa (Vivanti & Messinger, 2021). Through this lens, the study of infant/toddler representation of their social partners' attentional and

emotional capacities and meanings, and the communicative developments that support these processes, opened the way to a new way of understanding the difficulties that children on the autism spectrum have in establishing joint attention, sharing their desires, feelings, and thoughts with others, and developing language as a social communication system (Karmiloff-Smith, 2009; Rogers & Pennington, 1991).

Similar work in developmental psychopathology involving studies of imitation and pretend play allowed the field to pinpoint early differences in autism in the very areas that toddlers rely on to build their knowledge of the social world, of self and other as mentalizing beings, and of emotional expressions as signaling critical information about the outer environment as well as internal states. The studies of autistic development in the earliest years of life challenged the idea that young children on the autism spectrum followed a completely different path to learning than other children (Dube et al, 2016; Rieth et al., 2015; Tager-Flusberg et al., 1990). Studies of imitation, expressive language, object permanence, pretend play, and even joint attention (Carpenter et al., 2002; Kim et al., 2014; Young et al., 2011) demonstrated that autistic children had specific difficulties in these areas but nevertheless progressed in them, responded to efforts to stimulate learning in these areas (Pizzano & Kasari, 2020; Rogers & Talbott, 2016), and followed developmental trajectories in each of these various domains similar to their developmentally matched peers, both those with typical development and those with other developmental profiles (Carpenter et al., 2002; Talbott et al., 2020). However, for autistic children, relations across domains appear to differ in some cases, including findings of negative associations between attention following and communicative gestures (Carpenter et al., 2002) and atypical temporal relations between gestures and language in a substantial subset of toddlers on the autism spectrum (Talbott et al., 2020). Overall, these findings point to areas of overlap as

well as alterations in how knowledge is constructed in autism, which are best captured using a developmental perspective. In the following, we adopt a Piagetian framework to examine how early learning processes and outcomes might be constructed differently in typical development and autism.

Early Learning in Typical Development

According to constructivist accounts, knowledge acquisition in typical development is built on the child's active, self-directed engagement with a species-typical physical and social environment. Various constructivist theories share the notion that cognitive development reflects neither the passive unfolding of fixed maturational sequences nor a passive process of registering environmental stimulation. A common theme encompassing pioneering theoretical formulations (Montessori, 1912; Piaget, 1929) and contemporary scholarship on constructivism (Begus & Southgate, 2018; Heyes, 2018; Karmiloff-Smith, 2012) is the notion that cognitive development is constructed by an interplay between (a) biological, including cognitive, readiness to act on the environment, and (b) environmentally-provided learning opportunities. According to Jean Piaget's (1936/1963) influential account of human development, learning is enabled by complementary processes of assimilation and accommodation, both propelled by the child's motivation for mastery in understanding of how objects and people operate.

Assimilation refers to the child's use of existing knowledge to acquire (assimilate) novel information into existing patterns, or schemas, as occurs when a baby who has mastered grasping and shaking rattles now carries out these same actions on a novel object like a small handbell. In this example, the baby assimilates the novel bell into the existing "grasping" and "shaking" schemas. In contrast, accommodation refers to the child's alteration of an existing concept or schema to accommodate new learning that cannot be fitted (assimilated) into existing schemas or

concepts. For example, when trying to grasp and shake an object that is too large or heavy for the infant to pick up and shake with one hand, the infant may coordinate both hands to grasp the sides of the object. Shaking this object will require directional coordination of both hand movements, and the shaking pattern will occur vertically, in midline, a very different action than grasping a rattle and shaking it with one hand, requiring a significant accommodation of the well-practiced grasp and shake skill. The accommodation process allows for a new schema to emerge and adds complexity and differentiation to the child's cognitive modeling of the world.

Assimilation and accommodation shape, and are shaped by, patterns of a child's engagement with novel and familiar stimuli across both social and non-social activities. Piaget's original observations as well as subsequent research have emphasized how young children, when facing a moderate discrepancy between their current skills or understanding and the affordances of a new learning experience, do not avoid the new object/situation (Sobel & Letourneau, 2018). Rather, they are interested in the novelty and actively engage in exploration using their existing schemas, modifying their existing knowledge as needed to learn a means of operating on the novel stimulus. Engagement with moderately challenging situations requiring modification of existing skills/knowledge has been found to predict later social-cognitive and educational outcomes (Bornstein et al., 2014; Gottfried et al., 2001; Walker-Andrews et al., 2013), as would be predicted by constructivist theory.

Modifications of existing knowledge often occur during joint activities—activities shared with a partner (Toub et al., 2016). Indeed, although not consistently emphasized across Piaget's works, interaction with more knowledgeable social partners who have a wide repertoire of schemas and share them with infants provides discrepancies that motivate infants to understand these novel acts, thus providing opportunities to construct (and co-construct) new knowledge.

Importantly, in Piaget's view, social interactions do not entail the passive acquisition of "already made" knowledge—rather, in his own words "social transmission [...] furnishes the elements and the model for a possible construction [of knowledge], though without imposing this in a completed state" and the child "actively selects among available possibilities and reconstructs them and assimilates them in his own manner" (Piaget, 1977/1995, p. 33). This construction, Piaget (1977/1995) adds "only takes place as a function of the interaction between individuals, therefore under the [...] influence of differing actual modes of interaction" (p. 37).

Early Learning in Autism

One of the most puzzling phenomena seen in autistic children's learning is the contrast between their ability to generate large repertoires of knowledge within specific categories (e.g., memorization of lists and patterns, enhanced attention and learning in response to specific classes of stimuli) compared to their difficulties in developing generative patterns of action and communication (Jarrold et al., 1993; Kim et al., 2014). Additionally, many children on the autism spectrum show both the ability and the motivation to learn from practice and from the outcomes of their own actions that stand in contrast to their difficulties learning from novel situations and from others' actions and communications (Foti et al., 2019; Rogers & Williams, 2006; Vivanti et al., 2016a). Furthermore, longitudinal research has shown that autistic children who explore relatively fewer novel objects and engage less in joint activities than others have lower scores on cognitive measures over time, suggesting a link between early exploratory and social behavior, and cognitive development (Poon et al., 2012; Vivanti et al., 2013).

In this paper we propose a parsimonious and actionable hypothesis for understanding how these apparently disparate phenomena are interconnected with one another and how they are linked to other characteristics of autism. Our hypothesis is based on the notion that atypical early

learning in autism reflects, at least in part, the impact of aspects of autism itself on accommodation and assimilation. Specifically, as illustrated in Figure 1, we suggest that early manifestations of autism result in patterns of actions on the environment that are characterized by increased reliance on assimilation and a decreased reliance on accommodation, resulting in an atypical assimilation/accommodation balance.

There is considerable evidence that autistic children learn from practice, enjoy the process of practicing mastered schemas, and assimilate novel information within those schemas (McAuliffe et al., 2020; Vivanti et al., 2016a). Their language skills and sorting skills demonstrate both their ability to and interest in expanding (assimilating) the exemplars within specific schemas—color learning, animal names, alphabet letters in young children, and maps, countries and capitals, flags, song lyrics with older persons. Their ability to sort items into known categories does not appear to be affected beyond their overall developmental level (Ellawadi et al., 2016).

Accommodation, on the other hand, appears to be less frequently used in this population. Novelty does not appear to stimulate the same degree of curiosity and exploration in autism that it does in typical development (Anckarsäter et al., 2006; Arora et al., 2021; Vivanti et al., 2018). Examination of children's play skills reveals that children on the autism spectrum tend to use schema that are immature compared to their most developed skills, while children with typical development at the same maturity level tend to spend more of their time (and thus appear to be experiencing more pleasure) in their most newly acquired skills (Kasari & Chang, 2014; Libby et al., 1998). This over-practice of previously learned schema and under-practice of newer schema might contribute to slowing down learning in newly developing skill sets.

Several aspects of autism might underlie the proposed overreliance on assimilation as opposed to accommodation, including differences in the attentional, emotional and cognitive infrastructure that support learning experiences and processes during early development. In the following, each of these aspects is examined in turn—although, as illustrated in Figure 1, the impact of each on learning is conceptualized as an interplay between interconnected factors.

Autism-Specific Differences in Attentional, Emotional and Cognitive Processes

Contributing to an Atypical Balance of Assimilation/Accommodation

Attentional Processes

One aspect contributing to an increased use of assimilation over accommodation in autism concerns differences in the aspects of the environment to which young autistic children attend. From infancy onwards, autistic children show diminished attention to the human voice (Miller et al., 2017), reduced attention to social scenes (Chawarska et al., 2013; Hedger et al., 2020), disruptions in joint attention (Bottema-Beutel, 2016; Mundy, 2016; McEvoy et al., 2002), as well as reduced attention and responsivity to social models (Scambler et al., 2007) and ostensive cues, that is, communicative signals used by the adults to guide children's learning, such as establishing eye contact and modifying tone of voice to capture attention and highlight salient aspects in the environment (Vivanti et al., 2016a,b, 2017). Additional findings include decreased disengagement of attention (Sacrey et al., 2014) as well as heightened sensory interests and sensory seeking (Baranek et al., 2018; Damiano-Goodwin et al., 2018; but see also McCormick et al., 2014). Autistic children often show increased attentional engagement with specific objects or parts of objects, and increased amount of time spent in repetitive object-oriented routines compared to their non-autistic peers (Fanning et al., 2021; McKinnon et al., 2019; Ozonoff et al., 2008). Additionally, experimental studies have documented that autistic

preschoolers, unlike their peers with typical development or other neurodevelopmental conditions, do not show a preferential attention towards novel versus repeated stimuli (Arora et al., 2021; Vivanti et al., 2018).

This attentional inclination towards non-social versus social stimuli and familiar versus novel stimuli reflect core characteristics of autism likely to alter the balance between accommodation and assimilation during early learning experiences by virtue of (a) decreasing opportunities to register and engage with novel situations that are discrepant from current skills and knowledge, and (b) decreasing opportunities to bridge such discrepancies through the observation of adults who scaffold development of new skills.

Emotional/Motivational Processes

Another aspect of autism that is relevant here concerns mastery motivation, the emotional/motivational drive to learn and master activities moderately discrepant from current skills and knowledge. Enhanced motivation involving the pleasure experienced when repeating familiar schema rather than practicing newer and more difficult skills may underlie repetitive patterns of play and activity as well as diminished variety within activities in autism. The emotional and motivational drive towards experiences centered around existing versus novel schemas is reflected both in the research data already cited and also in personal accounts by autistic adults, who emphasize the pleasurable nature of engagement in repetition and familiarity, particularly for stimuli of intense interest, associated with positive feelings of joy (Bascom, 2011) and heightened well-being (Grove et al., 2018). However, when motivation focuses on practicing already mastered skills rather than the pleasure of mastering new skills, learning can be affected, and this may contribute to the falling developmental quotients seen in the first two

years of life for many (although not all) young children on the autism spectrum (Fisch et al., 2002).

Additionally, typically developing children often bridge the discrepancies between what they understand and what they cannot quite understand by turning to a social partner who can support their mastery efforts. This process might be altered in young autistic children due to their reduced engagement with people. For example, compared to typically developing children, young autistic children orient less frequently to naturally occurring social stimuli, manifest fewer expressions of pleasure in response to social situations and show an increased engagement in solitary activities (Dawson et al., 1998; Klin et al., 2009; Wan et al., 2013). This might result in a diminished engagement in situations in which adults show and scaffold the use of new schemas (Vivanti & Nuske, 2017). In an experiment by Vivanti et al. (2014), preschoolers on the autism spectrum tended to use their existing skillset to achieve the goal that was demonstrated to them, rather than imitating the novel actions used by the model to achieve the goal, while children matched by developmental age imitated the unfamiliar action to accomplish the goal (see also Whiten & Brown, 1998). Along similar lines, Young et al. (2016) found that, when confronted with verbal instructions that exceeded their level of understanding, preschoolers with developmental delays, but not autistic preschoolers, engaged in information-seeking behaviors to gain further information or meaning on what they have encountered.

A final emotional/motivational factor affecting autistic children's patterns of action in social and non-social environments is anxiety that may occur in response to novel, or unfamiliar situations, actions, or people. Being confronted with novel stimuli creates dissonance that appears to fuel motivation to master novel stimuli in typically developing children. However, such dissonance, or conflict between what is readily assimilated and what is not, and the arousal

thus created, may be uncomfortable for some children on the autism spectrum, especially compared to the pleasure that results from repeated exercise of existing schemas, resulting in rejection, avoidance, or withdrawal from novel stimuli. Many autistic people describe feelings of discomfort and of being overwhelmed by sensory stimuli, particularly in the context of unfamiliar situations (Belek, 2018; Landon et al., 2016; Smith & Sharp, 2013). People, particularly unfamiliar people, could also have the potential to be over-arousing and anxiety-producing in autism. Recent research by Macari and colleagues (2020) suggests that autistic children display diminished attention and enhanced distress towards a novel, or unfamiliar person from toddlerhood on, in contrast to other studies documenting normative arousal in response to eye contact with familiar people (Nuske et al., 2014, 2015; Vivanti & Nuske, 2017). This suggests that emotional responses to social stimuli are mediated by the familiarity of the situation in the autistic population.

Cognitive – Representational Processes

A final aspect that might result in an atypical construction of knowledge in autism involves alterations in the representation of the environment and its properties, particularly in the social domain. Differences in early representational thought in autism have been examined in studies involving imitation of actions and pantomime skills (Rogers et al., 1996; Rogers & Williams, 2006; Vivanti & Hamilton, 2014). Imitating another person involves representing their actions in memory and using that representation to direct one's own actions. Pantomime involves carrying out a known action pattern outside of the context that typically elicits it, and thus requires one to bring the situation and action patterns from memory into active mind and then using those representations to direct one's own actions in a very different context. Research in

this area has documented autism-specific difficulties, particularly for imitation/pantomime of unfamiliar actions (Rogers et al, 1996; Smith & Bryson, 2007).

Similarly, autistic preschoolers' atypical play behavior (Fanning et al., 2021) might involve atypical representational processes, in that the child produces acts and words related to certain known routines or experiences outside of those contexts by bringing them into active working space from long term memory and then matching actions and vocalizations to the mental representations. These skills appear to develop more slowly in autism than in other children given the same developmental abilities overall. Similarly, the construction of representations of self and others' emotional lives appears to be altered in the development of many children on the autism spectrum. The vocabularies of young children on the autism spectrum include fewer exemplars of mentalizing words as do other children (King et al., 2013; Tager-Flusberg, 1992), and many autistic children react atypically to others' emotional displays in ways that suggest altered emotion understanding (Sigman et al., 1992; Nuske et al., 2013).

On the other hand, autistic children do not seem to be impaired in their ability to learn concrete referents conveyed by communicative gestures and speech. Learning names of colors, shapes, animals, vehicles, and similar classes also involves representation, and this kind of learning is often a relative strength in autism, given their overall language skills. Object permanence skills, spatial relations, and means-end relations (sensorimotor stage 5 and 6 in Piaget's constructivist epistemology) also reflects types of representations that appear to develop in typical fashion in the early development of children on the autism spectrum (Carpenter et al., 2002; Sigman & Ungerer, 1981). Thus, representations of the physical world do not seem as altered in autism as do representations of animate beings seen in symbolic play, imitation, and representations of emotional states and mental states in self and other. The dissonance thus

created for children on the autism spectrum may lead to a decreased engagement in such activities, adding to alterations in knowledge construction, especially of the social world.

Towards a Constructivist Model of Early Learning in Autism

From a constructivist perspective, the early emerging differences in autism across attentional, emotional, and cognitive factors described above should result in a diminished engagement with (a) novel stimuli or new experiences in which the discrepancy between existing understanding and the challenge at hand requires a novel solution, and/or (b) social exchanges in which social partners demonstrate and scaffold solutions to the challenge. Diminished engagement with novel stimuli and preference for use of existing schemas represent a favoring of assimilation over accommodation, as the latter requires alteration of current ways of understanding. A higher ratio of assimilation over accommodation might be reflected in preferences for constancy, sameness, repetition, ordering, and predictability, characteristics not only of patterns of repetitive behaviors and actions seen in younger autistic children, but also the patterns in which people on the autism spectrum assimilate unusually detailed information on preferred subjects. Reduced reliance on accommodation might underlie difficulties involving creation of new ideas and new combinations of schemas needed for pretend play, in constructing novel combinations in expressive language, and in carrying out everyday activities when changes require ongoing and rapid modification of habits and concepts. In autistic adults, even those without intellectual disabilities, the atypical balance between assimilation and accommodation might contribute to difficulties in situations that involve rapid alteration in existing patterns of action, as required by driving, travel to new places, skilled and/or group conversation that requires rapid processing and topic flexibility depending on the social partners' content, shifting between tasks and initiating new tasks (difficulties with which are often described in the autistic

community as “autistic inertia”; Buckle et al., 2020), or adapting to disruptions in established routines.

Figure 1 illustrates the proposed model, whereby alterations in the balance between assimilation and accommodation contributes to the construction of divergent cognitive processes (how the child learns) and cognitive outcomes (what the child learns) in autism.

{{INSERT FIGURE 1 HERE}}

Relevant corollaries of this account include the following:

1. The degree to which the balance between accommodation and assimilation is atypical might be heterogeneous in the autistic population, reflecting individual differences in symptom expression and experiential learning.
2. Specific characteristics of the putative atypical accommodation/assimilation balance would differ across individuals on the autistic spectrum. For example, reduced engagement in experiences that are conducive to accommodation processes might be primarily caused by a diminished motivation for social engagement in some children, by increased pleasure/focus in response to familiar versus novel stimuli in other children, and by cognitive differences affecting processing of novel and/or social situations in other cases. Rather than positing a distinctive path from specific autistic manifestations to specific alterations in assimilation/accommodation, we suggest that different attentional, attentional/motivational and cognitive characteristics of autism make assimilation and accommodation processes more susceptible to alterations.
3. The hypothesized atypical balance between accommodation and assimilation does not disrupt the ability to learn in autism, but rather results in “hyper-learning” and “hypo-learning” in response to differing learning material that lends itself to reliance on either assimilation

(memorization, repetition) and accommodation (word problems, requirements for creating novel combinations). Thus, an atypical balance of assimilation and accommodation in autism should be viewed from a descriptive rather than a deficit perspective given that it can result in an alternative but not necessarily impairing profile of strengths and challenges.

Relevance of Our Constructivist Model of Early Learning in Autism to Neuroscience

Although constructivist perspectives on child development continue to be influential in developmental psychology and early childhood education (Odom, 2016), their role in guiding neuroscience studies of learning processes in typical and atypical development has been limited. In particular, the Piagetian concepts of assimilation and accommodation are rarely used in neuroscience research. Nevertheless, relevant exceptions exist. One such study used a computer simulation based on a hierarchical modular neural network architecture adapted to work with reinforcement learning (Caligiore et al., 2014). The model was constructed to autonomously learn the behavior of a simulated humanoid robot engaged in the task of acquiring different reaching skills. While the system solved new tasks, it started from previously acquired neural structures (which the authors likened to assimilation) and then updated them (which they likened to accommodation) to an extent that depended on the degree of similarity of such tasks with previously solved tasks. The authors offered the model as a framework for studying the possible consequences of atypical assimilation/accommodation processes during sensorimotor learning, asserting that such a process might occur in autistic individuals who often show difficulties in discriminating and generalizing motor behaviors.

Additionally, a recent study (Dirks et al., 2020) examined functional magnetic resonance imaging (fMRI) data from 7- to 12-year-old autistic and typically developing children using a set-shifting paradigm involving either detecting novel elements within a category, or engaging in

flexible switching between stimulus categories. While in the MRI scanner, participants viewed a display with three objects presented on a black background. One of the three objects (target object) differed from the other two in either shape (e.g., a square and two circles) or color (e.g., white circle and two gray circles). The only instruction participants were given was to identify the object that was different (target object) by pressing the corresponding finger (index, middle or ring) on a response pad. Trials were presented in a block design that included different conditions. In the “repeated block”, the feature that made the target object different (shape or color) was consistent across all trials in the block (for example, the target object consistently differed from the other objects by virtue of having a different shape). In the “mixed block”, the unique feature that made the target object different (shape or color) alternated between successive trials (in some trials, what made the target object different from the other objects was its shape, in other trials was its color).

From the standpoint of the assimilation/accommodation framework, the repeated blocks, where participants did not need to perform set-shifting from trial to trial, but only identify the object that was novel in either color or shape, can be thought of as related to assimilation, while the mixed blocks, where participants were required to continually shift from one “set” (or *schema*) to another, can be thought of as related to accommodation, or the alteration of an existing concept or schema to accommodate new learning. Results showed that autistic and neurotypical participants had equal accuracy and reaction times on both types of blocks, but autistic children, only, showed greater activation in the parahippocampal gyrus during mixed trials (which were designed to engage set-shifting) compared to repeated trials (which required only detecting the novel stimulus within a single category). These results suggest that while autistic children performed comparably to their typically developing peers on this relatively

simple task, they needed to recruit greater neural resources from a brain area that plays an important role in memory encoding and retrieval in order to reach similar behavioral levels on the task that relied more heavily on accommodation processes.

While the neuroscience evidence of the plausibility of this model is still sparse, there is information to be gleaned from what is available. In the study reviewed above as well as many others (e.g., Fourie et al., 2020; Oberwelland et al., 2017; Sommer et al., 2018), it is observed that differences between typically and atypically developing participants can be often seen at the neural but not at the behavioral level, suggesting that neuroimaging can be useful in revealing individual or group differences in cognitive processing that is occurring in the service of task performance. Thus, in examining assimilation and accommodation processes occurring during cognitive tasks, techniques that can reveal differing patterns of brain activation may prove particularly useful. It is clear that more work that begins with developmental theory and uses neuroscience techniques to test those theories (as opposed, for example, to work that starts with adult brain activation patterns in mind and looks for deviation from those patterns in children or across diagnostic groups) is critically needed.

Relevance of Our Constructivist Model of Early Learning in Autism to Autistic Advocacy

The Piagetian view of the learner as an agent in the construction of learning experiences is critical for themes regarding self-determination and appreciation of neurodiversity raised by advocacy groups in the autistic community. Self-determination—agency—and freedom are crucial for human well-being (Deci & Ryan, 2008; Sen, 1999). Moreover, self-determination may be even more vital for autistic individuals than neurotypicals insofar as autistic people have needs that differ and may need increased autonomy to structure their lives and environments in ways that facilitate thriving (Dwyer, 2020). This is true across the heterogeneous constellation of

strengths and needs within the autistic population (see AutAngel, n.d.; Fletcher-Watson & Happé, 2019), including individuals with limited communicative abilities, whose preferences, agency and self-determination needs are frequently undermined, affecting well-being, learning, and autonomy (Tomaszewski et al., 2020). As such, it comes as little surprise to learn that autistic and neurodiversity advocates devote considerable effort towards promoting self-determination and agency. Advocates have stridently opposed legal institutions that restrict the autonomy of neurodivergent people, such as guardianship/conservatorship (e.g., Autistic Self-Advocacy Network, 2016). More generally, autistic-led organizations have developed resources to promote and support self-advocacy, or “taking control of our own lives,” for adults (e.g., Autistic Self-Advocacy Network, 2015, n.d.).

Additionally, widely used Applied Behavior Analysis (ABA; Baer et al., 1968) -based early interventions are highly controversial in the autistic and neurodiversity advocacy communities because of their association with the adult-directed discrete trial teaching (DTT) methods pioneered by Lovaas and colleagues (1967; 1987).² Lovaas’ interventions and those stemming from his work involve a strong emphasis on children’s quiet attention to and compliance with adult instructions, and the use of both positive and negative consequences to teach and maintain compliance. Some autistic individuals who received this type of ABA intervention have retrospectively reported a variety of harmful impacts, particularly in the domain of self-determination (McGill & Robinson, 2020). Indeed, difficulties with compliance training and DTT instruction have been studied and alternatives developed, given the concern

² While the lay term discrete trial teaching, or DTT, is often used to describe this type of teaching, it is technically inaccurate. *Discrete trial teaching* refers to practicing skills repetitively in order to master them quickly and is an important learning technique for all people trying to master certain types of learning (e.g., golf swings, musical scales, multiplication tables, new vocabulary words, etc). A more appropriate term for this type of teaching is *adult-directed teaching, or didactic instruction*. For the purposes of this paper, we will use *adult-directed teaching*.

regarding increased negative affect and prompt dependence sometimes associated with these adult-directed practices (Koegel et al, 1987). The constructivist framework described in this paper suggests a number of ways in which intervention practices can support agency and self-determination for autistic people and thus be more acceptable to the autism community.

The first issue of contention involves the way adult-directed interventions override the agency and autonomy of autistic children (Chapman & Bovell, forthcoming; Wilkenfeld & McCarthy, 2020) by focusing on compliance to instruction and by using a teaching approach in which the “teacher” provides instruction and the child is taught to wait quietly and then respond as instructed. In such adult-directed interventions, autistic children are thus taught to comply with interventionist demands to gain rewards and to avoid punishment procedures (punishment refers to an unwanted consequence for an action such as loss of tokens, delays of breaks, overcorrection, etc.). Critics fear that such an approach can cause prompt-dependence, emotional reactions and frustration, learned helplessness, avoidance of adult-directed learning, and vulnerability to victimization (Sandoval-Norton & Shkedy, 2019). Evidence from studies directly comparing this type of teaching to naturalistic behavioral teaching (Koegel et al., 1992) have supported these concerns. Some autistic individuals reported receiving adult-directed ABA-based interventions that provoked fear, encouraged them to ignore their own needs, and made it more difficult for them to say no and protect themselves from harm, abuse, and exploitation (Gardner, 2017; McGill & Robinson, 2020; Stop ABA, Support Autistics, 2019). Autistic individuals also describe how their efforts to comply with task demands might be dismissed or unrecognized by interventionists (alexanderstreasuresblog, 2020; Kedar, 2012), leading to experiences of perceived failure, which, along with intervention-related dependence on prompts, could have

lasting effects on self-efficacy and motivation to learn (Sandoval-Norton & Shkedy, 2019; Sara, 2019).

Alternative effective early intervention approaches that avoid these potential iatrogenic effects have been developed and researched for over 40 years. These approaches, based on the use of positive behavior approaches and developmental science, use “naturalistic” strategies (natural in that these are ways in which adults and typically developing young children work together to support child learning), with their efficacy demonstrated experimentally (Vivanti & Zhong, 2020). Adults follow autistic children’s own interests and preferences in order to support children’s preferred activities—a signal of child internal motivation to engage in assimilatory and accommodatory learning. From the start naturalistic interventions teach communicative behavior that expresses children’s pragmatic intents by any means available (speech, sign, natural gesture, visual picture systems, etc.), including protest, choice-making, and requesting, and the rewards for child expression of these intents is the achievement of these goals. Such teaching approaches foster a balanced interaction via reciprocal and relatively equal initiations and responses by adults to children and children to adults, not by requiring autistic children into in a responsive, compliant role. This teaching style is designed to support and scaffold autistic children’s agency and self-advocacy (Rogers & Talbott, 2016; Vivanti et al., 2020) and has been described as more consistent with the priorities of autistic advocacy (including self-determination) compared to adult-directed instruction (Schuck et al., 2021).

Another criticism of ABA is its epistemological focus on external behavior without attention to the inner (emotional and mental) experience of the autistic learner (McGill & Robinson, 2020; Wilkenfeld & McCarthy, 2020). Adult-directed approaches tend to place agency and power in the hands of neurotypical interventionists, and prior research suggests that

those in positions of power demonstrate reduced perspective-taking (Galinsky et al., 2006), presumably because the opinions of the powerless have little effect on the well-being of the powerful. This finding of reduced perspective-taking is also at the heart of the research on empathy and the double empathy problem—the ways in which neurotypical individuals can struggle to understand and have empathy for autistic perspectives (and vice versa, see Edey et al., 2016; Heasman & Gillespie, 2018; Milton, 2012). The naturalistic interventions, including positive behavioral supports, require that interventionists consider the perspective of the autistic person in order to understand the pragmatic functions of behavior: how one’s behavior expresses one’s emotional and mental states, motivations, experiences, perspectives and understanding of the world. The interventionist’s role as a responsive partner and a provider of pragmatic communication tools that allow expression of one’s inner states is a necessary aspect of developing a strong sense of agency in the child. It can also be seen as a constructivist activity for the interventionist that leads to empathy and appreciation for autistic perspectives.

Finally, critics of interventions that emphasize “optimal outcomes” and include inhibition of “atypical behavior” have denounced the goal of “normalizing” autistic children: of promoting neurotypical behavior as a desirable end goal (Chapman & Bovell, forthcoming; Dawson, 2004; Wilkenfeld & McCarthy, 2020). These critics often point to ways in which some interventions have goals involving suppression of repetitive behaviors, or “normalizing” eye contact. Both of these characteristics may involve important self-regulatory mechanisms for autistic people (Hadjikhani et al., 2017; Kapp et al., 2019). Autistic advocacy criticizes intervention approaches that try to teach autistic people to adopt neurotypical mannerisms or to camouflage their symptoms as a goal in itself. There are ways that autistic behaviors can support learning, as when repetitive engagement with preferred objects is used as a consequence for mastery of a new skill,

or as a platform for then teaching variations of themes or more complex play behaviors, or as opportunities to engage autistic children in warm, positive social interactions. In these ways, autistic children’s learning environments facilitate learning while respecting and valuing children’s interests, talents, and choices—trying to build their repertoires of skills and knowledge and respecting who they are.

This raises the question of core characteristics of autism as intervention targets. Some outcome data from naturalistic interventions demonstrate not only increasing cognitive and communication ability or adaptive function scores, but also reduced scores on measures of autistic behavior (e.g., Estes et al., 2015). However, contemporary measures of autistic behavior are generally informed by a deficit/pathology model of autism, and they accordingly highlight challenges rather than strengths (Timini et al., 2019). It is therefore not clear that the outcome of lowered scores on autism measures must necessarily reflect becoming “less autistic”; this could reflect a change in the presentation of autism, specifically towards one associated with more strengths and fewer challenges. Naturalistic interventions informed by constructivist views on development aim to capitalize on child strengths in assimilatory learning and scaffold children to build developmental, educational, vocational and adaptive skills that will help them thrive as autistic people. Strategies to achieve this goal will be detailed in the following section.

Relevance of Our Constructivist Model of Early Learning in Autism to Early Intervention Practices

The proposed constructivist model of early learning in autism has several implications for autism early intervention practices. Through the lens of constructivism, early intervention should center on supporting the child’s neurocognitive and behavioral preparedness for interactions within specific experiences, both social and non-social, that facilitate learning, that is, the

acquisition of schemas in all domains: cognitive, linguistic, motor, social, emotional, artistic, musical, daily habits and routines. Each newly acquired and mastered schema in turn prepares the child to bring more knowledge to experiences, elaborating the child's foundation of knowledge and enabling the child to construct yet more complex schemas from related experiences, enhancing the knowledge base in an upward spiral, resulting in more advanced learning in all domains. Supporting this idea is recent research demonstrating that young children's tendency to prefer more complex learning opportunities reflects both motivational biases (for social and non-social stimuli) and more complex, or mature cognitive capacities (Schulz & Bonawitz, 2007; Tomasello, 2019).

Additionally, a constructivist lens to intervention entails that more mature social partners scaffold children's access to more complex learning opportunities in culturally specific ways as they interact during daily activities and play routines (Bruner, 1978), as seen when older children or adults direct a toddler's attention to relevant actions, thereby establishing a joint focus during object interactions; when partners elicit the child's verbal and non-verbal communicative initiations and responses (i.e., emotional expressions, gestures, words) through pauses, gestures and words during social interactions within daily care, play, and family routines, and when partners provide opportunities for social learning of culturally specific activities through immediate and delayed imitation.

Recent efforts to integrate constructivist concepts with ABA learning science have resulted in the development of Naturalistic Developmental Behavioral interventions (NDBIs; Schreibman et al., 2015), a class of early interventions supported by a growing body of literature, including rigorous randomized controlled trials, suggesting positive effects on child learning, particularly in mastery motivation (intrinsic rewards from learning), language, joint attention,

and representational abilities seen in imitation, language and pretend play (Fuller et al., 2020; Su et al., 2020; Tiede & Walton, 2019).

In the following, we examine how the intervention methods spelled out by one of the NDBIs—the Early Start Denver Model (ESDM; Rogers & Dawson, 2010)—may support learning in young children on the autism spectrum by addressing the alterations in assimilation/accommodation and related mastery motivation differences posited by our conceptual model (Figure 1). Several intervention strategies that are part of ESDM might facilitate this process:

1. Developing learning activities that fit well with each child’s zone of proximal development so that the child is always experiencing some familiarity of objects and actions;
2. Following children’s motivation into preferred activities and imitating children’s initiations of actions on objects to support child agency while creating an initial shared theme for the play activities;
3. Introducing variations in these established themes that introduce new learning goals for the child and scaffolding child imitation of the variation, which works novelty and resulting accommodation into each activity;
4. Increasing the salience and value of social partners and social learning and motivation via physical positioning, pleasurable games, helping, co-construction, fun effects, and all the other pleasurable aspects that social partners bring to interactions with young children.

These practices vary considerably from the highly structured, adult-directed discrete trial teaching (DTT) approach to intervention (Lovaas, 1981) which has dominated autism treatment until recently, with key differences reflecting the adoption of a constructivist framework. First, the starting points for constructing new knowledge in ESDM are the child’s current skill level

and the child's self-initiated actions, so that teaching steps are easily achievable and understandable and related to the child's internal motivation to master and achieve own goals. This procedure is in contrast to using prompts and extrinsic rewards to teach and motivate learning and might support accommodation by virtue of embedding opportunities to practice new schemas within child-initiated activities.

Additionally, following the child's lead and scaffolding (as opposed to directing) learning opportunities might support initiation, exploration, child autonomy and motivation to build self-driven and self-initiated learning during co-constructed activities. This is in contrast with directive teaching focused on obtaining child compliance as a prerequisite for teaching new skills, which might work against initiation and exploration.

A related concept is the role of the adult as play partner who adds value and embeds the reward in the learning activity. When the adults insert themselves in the child's self-initiated activity without interfering, but cooperating, with the child's goals, the dyadic activity becomes a source of reward in itself. Within this dyadic context, the adult has the possibility to enrich the activity and increase child pleasure while guiding the child's attention to novel stimuli/situations requiring accommodation of existing schemas and scaffolding acquisition of the new schemas. This is in contrast with adult-directed procedures based on extrinsic reinforcers and rewarding the child with breaks from learning, whereby learning is conceptualized as a "chore" and "freedom from demands" as the preferred state of affairs for the child.

Another naturalistic procedure consistent with a constructivist approach is the use of the child's repetitive behaviors as a theme upon which to build more mature schemas/actions as variations on the theme in response to novel additions involving objects, actions, or language. Variations provide an avenue for constructing opportunities for accommodation upon the child's

preferred actions/activities and accept the child's interests while building in challenges involving novelty, breadth and depth to the activity, while returning to the theme allows for the pleasure of assimilation to return. Alternating between theme and variations allows for interplay of comfort and challenge and allows for management of arousal and anxiety in the face of novelty. This is contrast with procedures focused on blocking repetitive behaviors and requiring their inhibition and substitution.

Additionally, naturalistic procedures are designed to stimulate representational thought by building up gestures to represent actions, pragmatic functions, and objects within joint activities that stem from the child's goals, and tying word learning and pretend play to the objects and actions that children are actively engaged in. This has the goal to support the use of internalized and verbal language for self-guidance, sharing, and learning, and support representations of the physical and social worlds at increasingly complex symbolic and mentalistic levels, including mental states and emotions. This approach is in contrast with training pretend play and other representational activities as a set of actions cued by word labels as opposed to representations of social acts that people do.

Further, naturalistic teaching focuses on embedding teaching and learning within everyday routines, thus capitalizing on assimilatory experiences (generalization of acquired schemas/skills across many environments and people), while facilitating accommodation, by exploiting the natural opportunities to accommodate schemas that occur in everyday environments and routines. This approach to making learning a part of all natural activities with others is in contrast to engineering learning activities as a didactic experience carved out of child's life and separate from everyday activities, with learning occurring at the table with a fixed beginning, end, and breaks. Similarly, mastery in ESDM is operationalized as a skill that the

child uses in multiple environments and multiple activities with multiple people in response to the environmental antecedents that would elicit the same behavior in children without autism—as opposed the successful demonstration of a taught act in the teaching situation.

These strategies informed by constructivism, while in contrast with adult-directed behavioral procedures, are still consistent with knowledge from ABA (Vivanti & Stahmer, 2021), and are applied alongside effective ABA procedures that include (a) the use of antecedent-behavior-consequence relations to support child learning, (b) breaking skills down into small steps and teaching them sequentially, (c) using positive reinforcement to motivate participation and practice, (d) building skills in attention to social partners, imitation of others, and social communication as critical sources of child learning, (e) embedding many opportunities for motor practice of new skills into learning, and (f) combining communication, social responsivity and intentional actions into all learning activities.

Naturalistic/developmental procedures and behavioral strategies incorporated in ESDM have been shown to equally contribute to successful child learning (Zitter et al., 2021). Importantly, however, research comparing adult-directed versus naturalistic/developmental styles of intervention informed by constructivism is in its infancy. A testable hypothesis to be addressed in future research is that children receiving naturalistic/development interventions based on constructivism, such as ESDM, might show more initiation of ideas and interactions and richer and more varied play inside dyadic free play and pretend play interactions with adults who are following children's leads and being play partners, while those receiving adult-directed instruction might perform better on standardized assessment measures with adults interacting in a didactic way.

Conclusions

In this article, we have sketched a constructivist model of early learning in autism and examined empirical supports and implications for autism research, advocacy, and early intervention. In young autistic children, alterations in the balance between assimilation and accommodation might contribute to the construction of divergent cognitive processes and cognitive outcomes, including atypical patterns of strengths and weaknesses. The proposed conceptual model and its implications are consistent with theoretical predictions from constructivism and a growing body of empirical research. However, additional research is needed in order to substantiate its validity and practical relevance. This includes stringent tests of the hypothesized atypical balance of assimilation and accommodations in autism, and its attentional, cognitive and emotional correlates. Falsifiable predictions from the model that should be tested include the more frequent use of assimilation versus accommodation in autism versus other populations as reflected in behavioral indicators and neural markers of assimilation and accommodation, as well as investigation on the pleasure derived from carrying out familiar schemas with new materials versus engaging in situations requiring modifications of existing schemas in autism. Finally, the longitudinal relationship between engagement in activities relying on assimilation versus accommodation and outcomes in autism should be examined, including outcomes related to long-term well-being, mental health, and self-determination. Additionally, future research should examine the added value of our proposed model in the context of the existing/alternative frameworks accounting for early learning differences in autism. For example, an interplay between cognitive and emotional/motivational factors in shaping early learning in autism proposed in our model has similarly been posited by Doebel's (2020) executive functioning account, which suggests that both an altered motivation to recruit executive functions in response to social stimuli, and an altered ability to use executive functions

even when motivation is high, might affect social learning in autism. Other theoretical work, by contrast, has suggested that atypical social behaviors in autism might reflect idiosyncratic manifestations of sociability, rather than an altered underlying motivation or capacity for social interaction (Jaswal & Akhtar, 2019).

Although more research is needed to test areas of overlap and incompatibility with these and other theories, the constructivist nature of our framework has the potential to provide a comprehensive and parsimonious account that acknowledges both early learning strengths and needs in the context of idiosyncratic and malleable constructions of knowledge in autism.

Additionally, the adoption of our constructivist framework to conceptualize early learning in autism offers actionable insight related to advocacy and intervention, including a focus on promoting agency, self-determination and the active construction of knowledge shaped by positive interactions that are built on the learner's motivation. Early interventions informed by constructivism have the potential to support these goals and address reduced accommodation processes in autism in several ways. These include promoting attention and engagement in novel schemas that are not disconnected from the child's preferences and goals, increasing pleasure in novelty, exploration and interaction with novel stimuli and situations, as well as scaffolding ways to master new schemas during ecologically meaningful daily routines and play interactions built on the child's goals. By building on the child's preferences to promote the motivation and ability to exercise accommodation processes (altering existing schemas to accommodate new learning experiences), these intervention techniques appear to be well equipped to both capitalize on each child's unique strengths and preferences and address their needs across the heterogeneous constellation of manifestations that characterize the autistic population.

Statements

Statement of Ethics

Not applicable; this article does not present the results of any human studies.

Conflict of Interest Statement

Giacomo Vivanti receives royalties from the book *Clinical guide to early interventions for children with autism*, published by Springer. Giacomo Vivanti and Sally J. Rogers receive royalties from the book *Implementing the Group-Based Early Start Denver Model for Young Children With Autism*, published by Springer. Sally J. Rogers receives royalties from books on the Early Start Denver Model that are published by Guilford Press. No other authors declare a conflict of interest.

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GV, SJR, PD and SR, collaboratively conceived the model presented in the article and drafted the manuscript. GV, SJR, PD and SR have read, edited and approved the final manuscript.

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